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## A CLEW TO THE ORIGIN OF THE GEOMETRID MOTHS.

By A. S. PACKARD.

In examining the pupa of *Phryganidia californica*, and finding the more essential features to be as much like those of the Geometrid moths, as any other group, I came upon results entirely unexpected to myself, and which give a clew to the origin of this great group of moths. It has become evident that *Phryganidia* can neither be placed among the Zygænidæ, or Syntomidæ, though possessing some pterogostic features like those of the latter group.

Another fact considered was that the larva of *Melanchroia* (*M. cephise* and *M. geometroides*), formerly associated with the Lithosiidæ, have been shown by Dewitz to be Geometrids. Another is the absence of a pair of legs in the Nolidæ, which I find must by their pupal and other characters be regarded as a distinct family from the Lithosiidæ. Still another fact is the conclusion I have arrived at that the Lithosiidæ have almost directly descended from the Tineidæ or an extinct group closely allied to them, and that from the Lithosiidæ have arisen not only the Dioptidæ (perhaps including *Phryganidia*), the Cyllopodidæ and Hypsidæ, but also the Syntomidæ and Nyctemeridæ, as well as the Arctiidæ.

On reexamining the larva, pupa and imago of *Phryganidia* (we have no knowledge of the transformations of the genuine Dioptidæ as at present limited); it has seemed to me that it has little of fundamental value to separate it from the Geometrid moths.

First as to the larva of *Phryganidia*: while in the shape of the head and the slender cylindrical body it differs little from the larva of *Melanchroia*, and of Geometrids in general; if the three anterior pairs of abdominal legs were atrophied, there would be no essential difference. That this is probable is seen in the larva of *Nola* which has but four pairs of abdominal legs, one pair being atrophied.

The end of the body (8th abdominal segment) is humped, but the larvæ of the East Indian *Eusemia* and *Hypsa* are also humped at the end of the body. *Phryganidia* only differs in being slenderer, and without hairs, and seems more closely allied to the larvæ of the Hypsidæ than to those of any of the allied groups. It does not spin a cocoon.

The pupa is obtected, and in its essential features more like that of Geometrids than Lithosiidæ or any Zygænid or Syntomid

genera. It is naked and suspended by a remarkably long cremaster; the end of the abdomen is otherwise peculiar. The head presents no vestigial characters; there being no trace of maxillary palpi, of paraclypeal pieces, or apparently of labial palpi. With a complete knowledge of all its stages, it is still difficult to assign it a definite position. When we know more about the Dioptidæ, where it probably belongs, the problem may approach a solution, but that its affinities are closely with the Geometridæ is shown by comparing the pupa with that of *Cleora*. In the general shape of the head, of the eyes, of the front, and especially of the abdomen, the resemblance is close; the peculiar shape and markings of the last three abdominal segments are nearly identical in both genera, though the cremaster of *Cleora* is much shorter.

In this connection reference should be made to the striking resemblance between the pupæ of *Oeta aurea* and *Cleora pulchraria*. To my great astonishment I find the pupa of *Cleora* has the same vestigial head-characters as *Oeta*; the general shape of the pupa is the same; the mode of dehiscence the same, the shape of the vertex and its mode of separating when the moth issues from the pupa case; also the shape of the eyes, of the peculiar clypeus and labrum, while the more pronounced vestigial characters are the labial palpi, forming a triangular area, and the large semi-detached paraclypeal pieces. *Cleora* shows that it is a more modern form in having no traces of a vestigial eye-collar (maxillary palpi) such as occur (though very slightly developed) in *Oeta*. The shape of the end of the body, with the cremaster, is much the same, the shorter cremaster of *Cleora* being an adaptation to its life in a slight open-work cocoon. In the peculiar markings of the 8th and 9th abdominal segments *Cleora* is more like *Phryganidia*.

Judging by the pupal characters, then, the Geometrids have directly descended from the Lithosiidæ, the latter, as I have satisfied myself, having directly originated from the generalized Tineina.

The imago of *Phryganidia* appear not to differ much from those of the Dioptidæ to which it has been referred by Butler. I am unable to see any important differences between the Dioptidæ and Cyllopodidæ, though my material is scanty. In the slender body, shape of the head, and proportions of the clypeus, shape of antennæ and palpi, both of these families do not essentially differ from *Melanchroia* which is now known to be a Geometrid, nor from the Geometrids themselves.

In its venation *Phryganidia* is nearly identical with that of a

*Josia* from Jalapa, Mexico, in my collection ; the peculiarity is the origin of veins II<sub>2</sub> and III<sub>3</sub> from a common stem, in which *Phryganidia* apparently differs from some if not all other Dioptidæ. But the venation of the Dioptidæ (including *Phryganidia*) and of the Cyllopodidæ is nearly identical with that of *Melanchroia*, and the latter is a true Geometrid in its venation, and in the shape of its larva, being a looper ; of its pupa we know nothing. The venation of the Geometrids is very persistent. Hence I conclude that the day-flying usually bright colored Dioptidæ and Cyllopodidæ, as well as the Hypsidæ, are direct off-shoots from the Lithosian stem, and their general resemblance to such Lithosians as *Crocota* and *Eudule*, as well as *Ameria*, is based on real affinity. The day-flying habits of some Geometrids is also well known. The larva of *Euphanessa* is a Geometrid, but its moth has been usually associated with the Lithosiidæ, though its venation is Geometrid. Riley describes the larva of *Octa aurea* as having "extremely small" anterior abdominal legs, the anal being much larger. Probably when we learn more of the transformations of the families we have mentioned it will be found that the presence or absence of certain abdominal legs will be found to be a secondary adaptational character. It is noticeable that the dull colored *Phryganidia* with only incipient clouds instead of bars and spots is a primitive form as regards markings.

After an examination of the pupal and imaginal characters of Geometrids, Dioptids, Hypsids and Syntomids it seems to me that all these groups represent more or less parallel lines of development which originated from the generalized Lithosiidæ, the latter, with the Zygænidæ, having sprung from generalized Tineina. The Nolidae represent a side branch, which evolved from a Lithosian perhaps like *Clemensia*. The Arctiidæ have also apparently directly descended from the Lithosiidæ. The Syntomidæ and Nyctemeridæ which seem closely allied by larval characters have also directly descended along another line from the Lithosiidæ.

Finally it appears that the Geometridæ are a more primitive type, and have no relationship to the Noctuidæ, the latter having more or less directly descended from the Agaristidæ, the latter from the Hypsidæ or allied forms perhaps extinct. The fact that the young larvæ of many Noctuidæ have only two pairs of legs has no phylogenetic significance.

In this preliminary abstract space has prevented giving details and figures to prove the truth of the assertions and conclusions here presented.